Design of 4S Web Services Model for the Infrastructures of National Spatial Clearinghouse of Spatial Data and Services

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Abstract: Recently, web services concept is rapidly rising as new solution to solve the integration problem among heterogeneous application systems . This web services concept is adaptable in the field of 4S application systems integration that handles the spatial information of GIS, SIIS, GNSS and ITS. So, this paper suggests a new 4S web services model for the infrastructures of nationwide spatial clearinghouse, which is mainly based on the OGC and W3C web services specifications. Conclusively, this proposed model that could serve various spatial data and services has some advantages of being flexibly and powerfully capable of integrating the 4S application systems owing to adapting the international standard specifications of OGC and W3C.
Keywords: Spatial Clearinghouse, WMS, WFS, WCS, WRS.

1. Introduction

Recently, web services technology is rapidly rising as new solution to solve the integration and sharing problems among heterogeneous distributed application systems. We think this web services technology could solve the problem of previous integration and sharing solutions such as COM and CORBA and could be continuously improved as a new mechanism that integrates and shares lots of application systems with the low cost and high efficiency. This web services technology is also very adaptable to the integration and sharing of 4S application systems that handles the spatial information of GIS, ITS, SIIS, GNSS[10]. Especially, it is almost impossible to build spatial data infrastructure(SDI)[11], which could integrate and share the all kinds of spatial information and services because of the diversity of spatial information systems. Therefore, we suggest a new 4S web services model(4S-WM) for building the nationwide SDI in this paper.

This 4S-WM is fundamentally based on the OGC web services model(OWS) and additionally accommodates the W3C web services concept. Detailed speaking, 4S-WM accommodates WMS(Web Map Services), WFS(Web Feature Services), WCS(Web Coverage Services), WRS(Web Registry Services), GML(Geographic Markup Language) specifications of OGC and SOAP(Simple Object Access Protocol), UDDI(Universal Discovery Description and Integration), WSDL(Web Services Description Language) specifications of W3C. And this 4S-WM is mainly composed of 4 kinds of spatial server of GIS, ITS, SIIS, GNSS, extended WRS broker that manages spatial metadata, and client system. Conclusively, we think this 4S-WM that adapts the powerful and flexible concepts of OGC and W3C plays a main role in building nationwide SDI of KOREA.

The next chapter shows you the web services model of OGC and W3C as a related works, and the third chapter shows you the details of the proposed 4S-WM of this paper. And the last chapter handles the pros and cons of this 4S-WM and the future works.

2. Related Works

Web services concept is a kind of standardized software technology that could integrate and share various computer programs and a kind of business services using this technology. This web services concept has an advantage of flexibility by perfectly defining not mutual interoperable methods but only standard specifications for mutually sharable data among distributed systems. Also this concept has an advantage that could transparently access any web servers in any places, with any devices and at any time.

1) Web Services of W3C

Web services standard architectures of W3C is composed of XML(extensible Markup Language), UDDI(Universal Discovery Description & Integration), WSDL(Web Services Description Language), SOAP(Simple Object Access Protocol). Here, the purpose of UDDI is to build a distributed global registry that could be accessed through web environment. In other words, the purpose is to build a kind of services market broker; various services can be registered to this broker and users can search for specific services using this broker. WSDL as a kind of language that define usages of web services is used in order to describe the interface name, argument and return value of serviceable programs[8]. SOAP is a protocol that enables users to mutually communicate their services under distributed environment using powerful XML[7]. The basic process of web services framework as follows (Fig. 1).

1. Servers publish their services to registry.
2. Clients search for their desirable services using registry.
3. And the search results are transmitted to clients.
4. Clients bind to servers using the search results.
5. And the service results are given to clients.

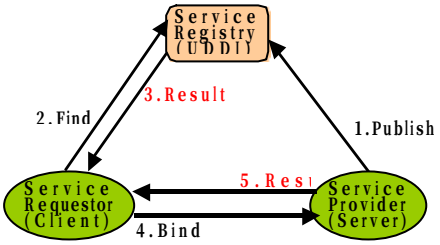

Fig. 1. Web Services Framework

2) Web Services of OGC

OGC fundamentally proposed various standard implementation specifications of WMS, WFS, WCS, SCS(Sensor Collection Services) and GML so that they can smoothly serve diverse spatial information of image map, vector map, satellite image and sensor information. Here, WMS specification defines the method that transmits the image map such as JPG or GIF[5]. On the contrary, WFS specification defines the method that transmits the vector map of GML format[2]. Sometimes, this WFS proposes the functions of spatial operator and transaction services besides the vector-based map service. And this WFS needs the specific viewer in client, for example GML viewer, to display vector map[4]. WCS specification includes the implementation details that transmit Grid, TIN, ThiessenPolygon and etc information related to satellite imagery information. This specification also needs the specific viewer in client to display satellite imagery information, for example GeoTIFF[6]. To and end, WRS specification defines methods of metadata registration, management and searching[3]. Based on these implementation specifications, OGC announced the ORM(OpenGIS Reference Model) in order to design web services of various spatial information, which are based on the web service technology of W3C (Fig. 2).

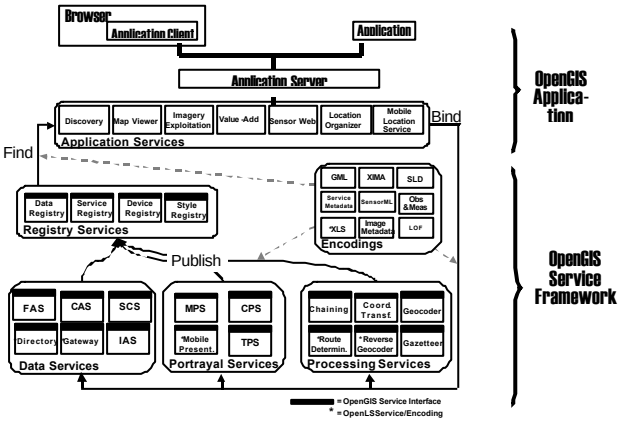

Fig. 2. OpenGIS Reference Model(ORM) of OGC

As seen in Fig. 2, ORM is analogous to web services model of W3C in that ORM is composed of Publish, Find and Bind[1].

3. 4S Web Services Model (4S-WM)

The 4S-WM proposed in this paper is fundamentally based on the WMS, WFS, WCS and WRS specifications and additionally accommodates UDDI, SOAP and WSDL specifications (Fig. 3).

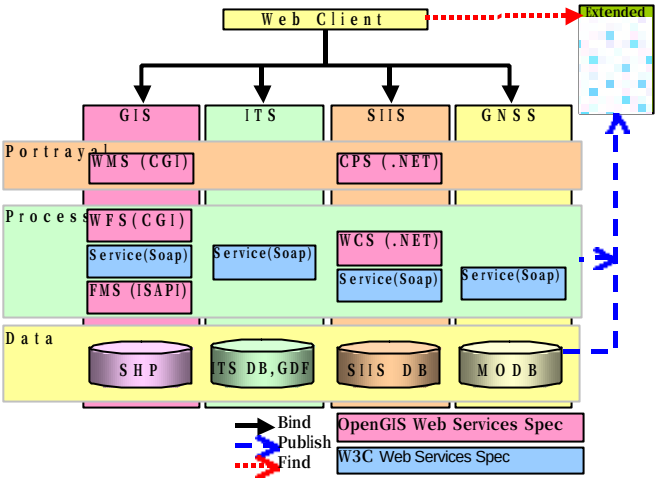

Fig. 3. 4S Web Services Model (4S-WM)

As you see in Fig. 3, this 4S-WM consists of 4 spatial server of GIS, ITS, SIIS, GNSS that performs the functions of data, process and portrayal, an extended WRS broker that manages metadata about spatial server and client system.

1) Spatial server

Each GIS, ITS, SIIS, GNSS servers of this paper has completely different structures in that their spatial data are accessed and their services are served. Nevertheless, the 4S-WM proposes how spatial servers of completely different structures could be efficiently integrated and shared in distributed environment. The detailed explanation of the 4S-WM as follows.

First, GIS server of this paper is main memory-based application server which loads all spatial data in memory as a form of GML or WKB(Well Known Binary) before it starts services. This server includes WMS, WFS and SOAP wrapping implementation in order to serve image map, GML vector map and some services such as spatial searching. Second, ITS server, as a server that is used for real ITS applications, is composed of two DBs of CNS(Car Navigation System) DB and traffic DB and some ITS services such as shortest path finding and real time traffic information offering. In this ITS server, we integrated and shared the ITS services of 'real time shortest path finding', 'real time traffic information collection' and 'moving trajectories management of probe car' rather than two DBs using web services technology. Therefore, these ITS services should be published into the extended WRS and could be accessed using WSDL stored in the extended WRS. Third, SIIS server of this paper plays a main role in managing satellite imagery DB (SIDB), finding some specific satellite images and deploying the SIDB. Therefore, we designed SIIS server

that could serve SIDB contents as a form of image map and GeoTIFF by implementing the WCS and CPS specification of OGC standards. In addition to services of SIDB contents, we designed how SIIS services could be performed as a standardized method. To an end, MODB(Moving Object DB) server used in LBS(Location Based services) project is adapted as a GNSS server in this paper. The main functions of the MODB server are moving objects finding, current location identification of moving objects, past location trajectory identification of moving objects, and so on. Conclusively, this paper proposed how all kinds of spatial services and data could be served using web services technology.

2) Extended WRS broker

Generally, the main role of WRS broker is to manage metadata about 4S spatial data. However, the WRS model of this paper has to manage metadata about not only 4S spatial but also 4S spatial services. So, this WRS model must be extended so as to satisfy the above requirements by accommodating W3C web services technology. This extended WRS broker consists of metadata management component for registration, authentication, and management of spatial data and services, metadata search component for finding previously registered spatial data and services and XML encoder and decoder component for importing and exporting metadata as a XML format (Fig. 4).

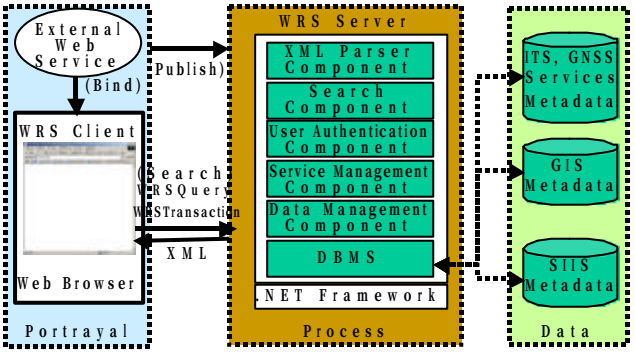

Fig. 4. Extended WRS Broker

Also, this WRS broker includes the implementation of Yellow page, White page and Green page, which are one of main contents of UDDI specification, so as to satisfy XML based web services model. The yellow page enables clients to search for metadata about spatial data and services by itemizing the all metadata and the white page enables service providers to register spatial data and services. The green page describes the detailed explanation about the way to utilize the yellow and white page.

3) Clients

Client systems could be classified with two categories; one is web browser client system and another is private client system for displaying some specific spatial data such as GML or GeoTIFF.

4. Conclusions

In this paper, we proposed the 4S-WM that is based on WMS, WFS, WCS and WRS implementation specifications of OGC and additionally accommodates web services technology of W3C. In other words, we proposed new solution that could easily integrate and share spatial information and services among different spatial servers through this 4S-WM under distributed environment. Especially, this model exceeds in the extensibility and flexibility as a solution to integrate and share spatial information and services under by adapting international standard specifications of OGC and W3C. Therefore, this model could be easily used when the nationwide spatial clearinghouse is built. However, this 4S-WM has some potential problem in the performance when spatial data or services are served in the GML format through internet because of large volume of GML data[9]. Therefore, we will focus our next research on the speedup of the 4S-WM.

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References

[1] OpenGIS Consortium Inc, Web Services Architecture, version 0.3, 18-January 2003.
[2] OpenGIS Consortium Inc, Geography Markup Language Implementation Specification, version 2.1.2, 17-September 2002.
[3] OpenGIS Consortium Inc, OWS Registry Service, version 0.7, 18-January 2003.
[4] OpenGIS Consortium Inc, Web Feature Service Implementation Specification, version 1.0.0, 19-September 2002.
[5] OpenGIS Consortium Inc, Web Map Service Implementation Specification, version 1.1.1, 16-January 2002.
[6] OpenGIS Consortium Inc, Web Coverage Service Implementation Specification, version 0.9, 18-December 2002.
[7] W3C Consortium, SOAP, version 1.2, 24-June 2003.
[8] W3C Consortium, Web Services Description Language, version 1.2, 11-June 2003.
[9] Lionel Savary and Karine Zeitouni, Spatial Data Warehouse – A Prototype, *Proc. EGOV'2003, LNCS 2739*, pp.335-340, 2003.
[10] Artur Rocha, Joao Correia Lopes, Luis Bartolo and Marco Amaro Oliveira, An Interoperable GIS Solution for the Public Administration, *Proc. EGOV'2003, LNCS 2739*, pp.345-350, 2003.
[11] Pauline Pollard, Spatial Data Infrastructure and E-Government: A Case Study of UK, *Proc. EGOV'2003, LNCS 2739*, pp.355-358, 2003.